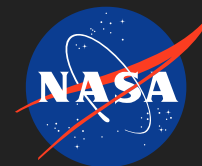


Topological Optimization and Automated Construction for Lightweight Structures

Completed Technology Project (2014 - 2018)



Project Introduction

The author proposes the development of an automated construction system for HEDS applications which will implement a game-changing material resource strategy combined with an innovative adaptation of state of the art additive manufacturing (AM) technology. In Situ Resource Utilization (ISRU) is achieved by relying on two elements which are readily available on the Lunar and Martian surfaces- solar energy and regolith- in a process that can be applied endlessly, allowing the formation of continuous load bearing and enclosing structures, such as roads, berms, landing pads, habitats, and garages. ISRU can be taken to the next level of material efficiency and independence through the Automated Regolith Laser Sintering system. The following aspects are addressed via unique characteristics of the ARLS system: Scale: the scale is limited only by the material, as there is no gantry system Material: the building material will be drawn primarily from the regolith of the surrounding area Energy: solar arrays will supply the ARLS mobile units with power for transportation and operation of the LENS 750 0.5kW continuous wave Nd-YAG laser. Geometry: Topology Optimization will be employed wherever possible in order to reduce the amount of time dedicated to each structure. Lifespan: not only can parts be built from scratch, existing parts can be repaired by adding thin layers where they are worn or damaged. Note: To measure progress, a figure-of-merit methodology will be created and employed to gain some quantitative insight into the efficiency of using the proposed robotic technologies. Load bearing and spanning enclosures and structural systems will be fabricated by the proposed method. Prior to the visiting technologist phase, a stationary version will be executed, and numerous net-shaped parts will be materialized and tested to failure to establish baseline correlation between proposed and actual structural performance. This will demonstrate ability and follow the roadmap to mobile operation.

Anticipated Benefits

ISRU can be taken to the next level of material efficiency and independence through the Automated Regolith Laser Sintering system. The following aspects are addressed via unique characteristics of the ARLS system: Scale: the scale is limited only by the material, as there is no gantry system; Material: the building material will be drawn primarily from the regolith of the surrounding area; Energy: solar arrays will supply the ARLS mobile units with power for transportation and operation of the LENS 750 0.5kW continuous wave Nd-YAG laser; Geometry: Topology Optimization will be employed wherever possible in order to reduce the amount of time dedicated to each structure; Lifespan: not only can parts be built from scratch, existing parts can be repaired by adding thin layers where they are worn or damaged.



Topological Optimization and Automated Construction for Lightweight Structures

Table of Contents

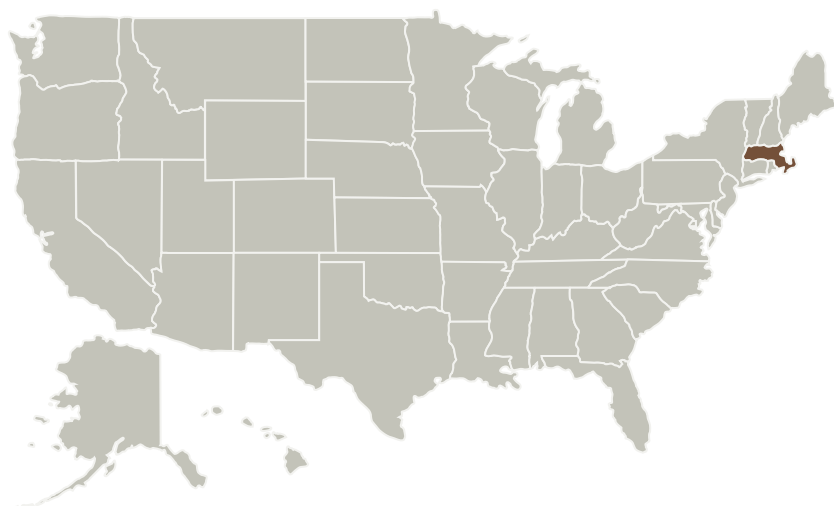
Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Project Website:	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	3
Technology Areas	3
Target Destinations	3

Topological Optimization and Automated Construction for Lightweight Structures

Completed Technology Project (2014 - 2018)



Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Massachusetts Institute of Technology(MIT)	Lead Organization	Academia	Cambridge, Massachusetts

Primary U.S. Work Locations
Massachusetts

Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Massachusetts Institute of Technology (MIT)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Neil Gershenfeld

Co-Investigator:

Benjamin Jenett

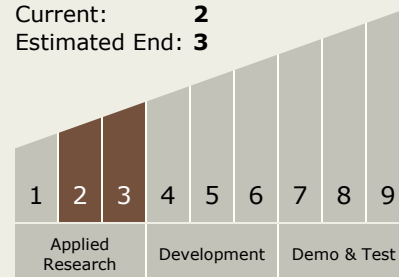
Topological Optimization and Automated Construction for Lightweight Structures

Completed Technology Project (2014 - 2018)



Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX07 Exploration Destination Systems
 - └ TX07.2 Mission Infrastructure, Sustainability, and Supportability
 - └ TX07.2.3 Surface Construction and Assembly

Target Destinations

The Moon, Mars